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Downscaling projections of future daily rainfall over Malaysia using non-homogeneous hidden Markov Model

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A statistical downscaling approach based on Non-homogeneous hidden Markov model (NHMM) has been used to project the future daily rainfall in Malaysia based on the SRES emission scenario A2 and B1. A 35 years record of daily total rainfall at 17 stations obtained from the Malaysia Meteorological Department (MMD) was used in this study. The downscaling exercises focus on two main monsoon seasons - i) the summer monsoon and ii) the winter monsoon. The summer (winter) monsoon is generally associated to drier (wetter) condition over Malaysia. For model calibration, the large scale predictors were taken from the reanalysis product of the National Centers for Environmental Prediction (NCEP). For future rainfall projection, the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset is used. Three main time slices were chosen: 1971 to 2000 representing present day simulations, while year 2046 to 2065 and 2081 to 2100 were used for future climate projections. Results suggest that Malaysian daily rainfall is associated to five distinctive weather states during the summer monsoon and six different weather states during the winter monsoon. The combination of two predictors i.e sea level pressure and air temperature at 850-hPa, has been identified as optimal predictor. A total of 13 general circulation models (GCMs) have been used as driver models. Generally, the downscaled GCMs simulations were found best in modeling the winter monsoon comparatively to the summer monsoon. The rainfall indices that were indicative of rainfall occurrence were better modeled compare to those indicative of rainfall intensity. The downscaled GCMs simulations are able to reproduce the rainfall probability well. In addition, the downscaled GCMs simulations of the duration distributions provide good approximations to the observed distribution although some GCMs tend to produce too-light-tailed distribution.